

CLAIMS

1. A multi-point probe for testing electric properties on a specific location of a test sample, comprising:
 - 5 (a) a supporting body defining a first surface;
 - (b) a first multitude of conductive probe arms each of said conductive probe arms defining a proximal end and a distal end being positioned in co-planar relationship with said first surface of said supporting body, and said conductive probe arms being connected to said supporting body at
10 said proximal ends thereof and having said distal ends freely extending from said supporting body, giving individually flexible motion to said first multitude of conductive probe arms; and
 - (c) said conducting probe arms originating from a process of producing said multi-point probe including producing said conductive probe arms on
15 supporting wafer body in facial contact with said supporting wafer body and removal of a part of said wafer body providing said supporting body and providing said conductive probe arms freely extending from said supporting body.
- 20 2. The multi-point probe according to claim 1, wherein said first multitude of conductive probe arms are unidirectional, constituting a first multitude of parallel free extensions of said supporting body.
3. The multi-point probe according to claims 1 and 2, wherein said supporting body
25 further comprising a second surface parallel to said first surface and said multi-point probe further comprising an additional multitude of conductive probe arms defining a proximal end and a distal end being positioned in co-planar relationship with said second surface of said supporting body, and said additional conductive probe arms being connected to said supporting body at
30 said proximal ends thereof and having said distal ends freely extending from said supporting body, giving individually flexible motion to said additional multitude of conductive probe arms.

4. The multi-point probe according to claims 1-3, wherein said first multitude of conductive probe arms are in a multiple of 2, ranging from at least 2 said conductive probe arms to 64 said conductive probe arms, preferable application having 4 said conductive probe arms.
5. The multi-point probe according to claims 1-4, wherein said first multitude of conductive probe arms have a substantially rectangular cross section defining: the dimension of width as a distance between the lines of said rectangular cross section perpendicular to the plane of said first surface of said supporting body, the dimension of depth as a distance between the lines of said rectangular cross section parallel to the plane of said first surface of supporting body, and the dimension of length as a distance from said proximal end of said conductive probe arms to said distal end of said conductive probe arm.
6. The multi-point probe according to claims 1-5, wherein said first multitude of conductive probe arms have a ratio of said length to said width within the range of 500:1 to 5:1, such as ratios 50:1 and 10:1, preferable application having the ratio of 10:1.
7. The multi-point probe according to claims 1-6, wherein said first multitude of conductive probe arms have a ratio of said width to said depth within the range of 20:1 to 2:1, preferable application having the ratio of 10:1.
8. The multi-point probe according to claims 1-7, wherein said first multitude of conductive probe arms has tapered elements extending from said distal end of said conductive probe arms.
9. The multi-point probe according to claims 1-7, wherein said first multitude of conductive probe arms has pointed shaped elements extending from said distal end of said conductive probe arms.

10. The multi-point probe according to claims 1-7, wherein said first multitude of conductive probe arms has enlarged circular, elliptic or orthogonal squared elements extending from said distal ends of said conductive probe arms.
- 5 11. The multi-point probe according to claims 1-10, wherein said first multitude of conductive probe arms have said lengths in the range of 20 μ m to 2mm, preferably a length of 200 μ m.
- 10 12. The multi-point probe according to claims 1-11, wherein said first multitude of conductive probe arms have a separation of distal ends of said conductive probe arms in the range of 1 μ m to 1mm, preferable application having said separations of 20 μ m, 40 μ m and 60 μ m.
- 15 13. The multi-point probe according to claims 1-12, further comprising a second multitude of conductive electrodes being positioned on second multitude of areas defined on said first surface between said first multitude of conductive probe arms, and comprising an insulating spacing between said electrodes and said conductive probe arms, said second multitude of conductive electrodes especially being suitable for active guarding.
- 20 14. The multi-point probe according to claim 13, wherein said second multitude of areas are swaged in relation to the plane of said first surface of said supporting body.
- 25 15. The multi-point probe according to claim 13, wherein said second multitude of areas are elevated in relation to the plane of said first surface of said supporting body.
- 30 16. The multi-point probe according to claim 13, wherein said second multitude of areas are in co-planar relation with said first surface of said supporting body between said first multitude of conductive probe arms.

17. The multi-point probe according to claims 13-16, wherein said second multitude of areas are combinations of swaged, elevated and co-planar in relation to the plane of said first surface of said supporting body.
- 5 18. The multi-point probe according to claims 13 and 17, wherein said second multitude of swaged areas undercut said first multitude of conductive probe arms on said supporting body providing a supporting surface of said supporting body smaller than the surface of said conductive probe arms facing said supporting body.
- 10 19. The multi-point probe according to claims 13, 17 and 18, wherein said second multitude of swaged areas undercutting said first multitude of conductive probe arms are originating from a process of producing said multi-point probe including producing said conductive probe arms on supporting wafer body in facial contact
- 15 with said supporting wafer body and removal of a part of said wafer body providing said second multitude of swaged areas on said supporting body by a process of chemical vapour deposition (CVD), plasma enhanced CVD (PECVD), electron cyclotron resonance (ECR) or sputtering, mechanical grinding, etching, high resolution lithographic methods such as electron-beam lithography, atomic
- 20 force microscopy (AFM) lithography or laser lithography.
20. The multi-point probe according to claims 1-19, wherein supporting body is of a ceramic material.
- 25 21. The multi-point probe according to claims 1-19, wherein supporting body is of a semiconducting material.
22. The multi-point probe according to claim 21, wherein said semiconducting material comprising Ge, Si or any combinations thereof.
- 30 23. The multi-point probe according to claims 20-22, comprising:
- (a) a conductive layer positioned on said multitude of conductive probe arms; and

- (b) a conductive layer acting as said electrodes on said supporting body between said first multitude of conductive probe arms.

5 24. The multi-point probe according to claim 23, wherein said conductive layer comprising conductive materials such as Au, Ag, Pt, Ni, Ta, Ti, Cr, Cu, Os, W, Mo, Ir, Pd, Cd, Re, conductive diamond, metal silicides or any combinations thereof.

10 25. The multi-point probe according to claims 1-24, wherein said multi-point probe further comprising:

- (d) a third multitude of conductive tip elements extending from said distal end of said first multitude of conductive probe arms; and
(e) said conductive tip elements originating from a process of metallization of electron beam depositions on said first multitude of conductive probe arms at said distal ends thereof.
- 15

20 26. The multi-point probe according to claim 25, wherein each of said third multitude of conductive tip elements comprises a primary section and a secondary section, said conductive tip elements being connected to said conductive probe arms through respective primary sections thereof and said secondary sections defining free contacting ends.

25 27. The multi-point probe according to claims 25 or 26, wherein each of said primary sections defines a first axial direction, said first axial direction constituting an increase of the total distance between said supporting body and said free contacting ends.

30 28. The multi-point probe according to claim 27, wherein said first axial direction of said primary section constitutes a decrease of separation between said free contacting ends of said third multitude of conductive tip elements.

29. The multi-point probe according to claims 27-28, wherein said first axial direction of said primary section constitutes a decrease of separation between adjacent said free contacting ends of said third multitude of conductive tip elements.
- 5 30. The multi-point probe according to claims 25-29, wherein each of said secondary sections defines a second axial direction, said second axial direction constituting an increase of the total distance between said supporting body and said free contacting ends.
- 10 31. The multi-point probe according to claim 30, wherein said second axial direction of said secondary section constitutes a decrease of separation between said free contacting ends of said third multitude of conductive tip elements.
- 15 32. The multi-point probe according to claims 30-31, wherein said secondary axial direction of said secondary section constitutes a decrease of separation between adjacent said free contacting ends of said third multitude of conductive tip elements.
- 20 33. The multi-point probe according to claims 27-32, wherein said first axial direction of said primary sections extend parallel to the plane defined by said first surface of said supporting body.
- 25 34. The multi-point probe according to claims 27-32, wherein said first axial direction of said primary sections extend in a direction converging towards the plane defined by said second surface of said supporting body.
- 30 35. The multi-point probe according to claims 30-34, wherein said second axial direction of said secondary sections extend parallel to the plane defined by said first surface of said supporting body.
36. The multi-point probe according to claims 30-34, wherein said second axial direction of said secondary sections extend in a direction converging towards the plane defined by said second surface of said supporting body.

37. The multi-point probe according to claims 25-36, wherein said third multitude of conductive tip elements is equal to said first multitude of conductive probe arms, preferable application having third multitude dividable with 2.
- 5 38. The multi-point probe according to claims 25-36, wherein said third multitude of conductive tip elements is less than said first multitude of conductive probe arms, preferable application having third multitude dividable with 2.
- 10 39. The multi-point probe according to claims 25-36, wherein said third multitude of conductive tip elements is greater than said first multitude of conductive probe arms, preferable application having third multitude dividable with 2.
- 15 40. The multi-point probe according to claims 25-39, wherein said third multitude of conductive tip elements have a separation of said free contacting ends of said conductive tip elements in the range of 1 nm – 100 nm, preferable application having said separations of 2 nm, 5 nm, 10 nm, 20 nm, 50 nm, 100 nm.
- 20 41. The multi-point probe according to claims 25-40, wherein each of said conductive tip elements define an overall length as distance between said distal ends of conductive probe arms and said free contacting ends of said conductive tip elements, said overall length being in the range of 100 nm to 100 μ m, preferable application having said overall length in the ranges 500 nm to 50 μ m and 1 μ m to 10 μ m.
- 25 42. The multi-point probe according to claims 25-41, wherein each of said conductive tip elements define a diameter, said diameter being in the range of 10 nm to 1 μ m, preferable application having said overall length in the ranges 50 nm to 500 nm.
- 30 43. The multi-point probe according to claims 25-42, wherein said third multitude of conductive tip elements mainly consists of carbon.

44. The multi-point probe according to claims 25-43, wherein said third multitude of conductive tip elements further consists a concentration of contaminants.
- 5 45. The multi-point probe according to claims 25-42, wherein said third multitude of conductive tip elements originate from a process of tilted electron beam deposition.
- 10 46. The multi-point probe according to claims 25-42, wherein said third multitude of conductive tip elements originate from a process of perpendicular electron beam deposition.
- 15 47. The multi-point probe according to claims 25-42, wherein said third multitude of conductive tip elements originate from a process of a combination of tilted electron beam deposition and perpendicular electron beam deposition.
48. The multi-point probe according to claims 25-47, wherein said metallization of said third multitude of conductive tip elements originates from a process of in-situ metallic deposition.
- 20 49. The multi-point probe according to claims 25-47, wherein said metallization of said third multitude of conductive tip elements originates from a process of ex-situ metallic deposition.
- 25 50. A multi-point testing apparatus for testing electric properties on a specific location of a test sample, comprising:
- (i) means for receiving and supporting said test sample;
 - (ii) electric properties testing means including electric generator means for generating a test signal and electric measuring means for detecting a measuring signal;
 - 30 (iii) a multi-point probe, comprising:
 - (a) a supporting body;
 - (b) a first multitude of conductive probe arms positioned in co-planar relationship with a surface of said supporting body, and freely

- extending from said supporting body, giving individually flexible motion of said first multitude of conductive probe arms; and
- (c) said conducting probe arms originating from a process of producing said multi-point probe including producing said conductive probe arms on supporting wafer body in facial contact with said supporting wafer body and removal of a part of said wafer body providing said supporting body and providing said conductive probe arms freely extending from said supporting body;
- (d) said multi-point probe communicating with said electric properties testing means; and
- (iv) reciprocating means for moving said multi-point probe relative said test sample so as to cause said conductive probe arms to be contacted with said specific location of said test sample for performing said testing of electric properties thereof.

15

51. The multi-point testing apparatus according to claim 50, wherein said electric properties testing means further comprising means for electric properties probing of said test sample.

20

52. The multi-point testing apparatus according to claims 50 and 51, wherein said reciprocating means further comprises holding means for said means for said multi-point probe.

25

53. The multi-point testing apparatus according to claims 50-52, further comprising means for positioning said holding means across said test sample and recording of a location of said holding means relative to said test sample.

30

54. The multi-point testing apparatus according to claims 50-53, wherein said means for positioning comprising manoeuvrability in all spatial directions, being directions co-planar to said test sample and directions perpendicular to said test sample.

55. The multi-point testing apparatus according to claims 50-54, wherein said means for positioning further comprising means for angular movement of said holding means, such as to provide angular positions for said means for said multi-point probe.

5

56. The multi-point testing apparatus according to claims 50-54, wherein said means for positioning further comprising means for angular movement of said holding means along an axis parallel to surface of said test sample, such as to provide angular positions for said means for said multi-point probe.

10

57. The multi-point testing apparatus according to claims 50-54, wherein said means for positioning further comprising means for angular movement of said holding means along an axis perpendicular to surface of said test sample, such as to provide angular positions for said means for said multi-point probe.

15

58. The multi-point testing apparatus according to claims 50-57, wherein said means for positioning further comprising means for sensing contact between said test sample and said means for said multi-point probe.

20

59. The multi-point testing apparatus according to claims 50-58, wherein said multi-point probe further includes any of the features of any of the claims 2-49.

60. A method of producing a multi-point probe comprising the following steps:

25

- (i) producing a wafer body;
- (ii) producing a first multiple of conductive probe arms positioned in coplanar and facial relationship with said wafer body;
- (iv) removing a part of said wafer body for providing said conductive probe arms freely extending from said non-removed part of said wafer body constituting a supporting body from which said conductive probe arms extend freely; and
- (v) producing a third multitude of conductive tip elements extending from said distal end of said first multitude of conductive probe arms.

30

61. The method according to claim 60, wherein the technique of applying the conductive probe arms in co-planar and facial relationship with the supporting wafer body, involves microfabrication technique, planar technique, CMOS technique, thick-film technique, thin-film technique or a combination thereof.

5

62. The method according to claims 60 and 61, wherein the technique of applying the third multitude of conductive tip elements extending from said distal end of said first multitude of conductive probe arms, involves metallization of electron beam depositions.

10

63. The method according to claims 60-62, wherein said producing of said third multitude of conductive tip elements comprising steps:

- (m) mounting of multi-point probe having said first surface of supporting body parallel to horizontal on to holding means in a microscope chamber;
- 15 (n) selecting angles α and β describing inclination of said primary section and said secondary section of said conductive tip elements;
- (o) measuring of deposition rate by focusing an electron beam in one location for 5 minutes and measuring the resulting length of a first deposition;
- 20 (p) tilting and rotating said holding means to give a field of view of said first deposition from an viewing angle identical to angle of said electron beam showing accordance with said selected angles α and β ;
- (q) depositing a length on one of said distal ends of said conductive probe arms;
- 25 (r) tilting and rotating said holding means to give a field of view of position for a second deposition;
- (s) depositing said length on neighbouring said distal end of said conductive probe arms;
- (t) repeating steps c through g until separation of conductive probe arms is approximately 100 nm greater than the indented separation of
- 30 (u) selecting an angle α_1 describing a inclination of said secondary section;

- (v) tilting and rotating said holding means selecting $\beta=0$ and selecting an $\alpha=\alpha_1$;
- (w) extending said secondary sections in continuation of said primary sections; and
- 5 (x) ensuring that the depositing progresses by alternating the position of the electron beam on first and second deposition.

64. The method according to claims 60-63, the multi-point probe having any of the features of the multi-point probe according to any of the claims 1-49.